OCCURRENCE OF THE WHALE BERARDIUS ARNUXI IN SOUTHERN AUSTRALIA

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Plates 5-6, and text fig. 1

SUMMARY

An adnlt female of the Beaked Whale *Berardius arnuxi* Duvernoy, stranded on a South Australian coast, is described herein. The relationship of the second species of the genus, *B. bairdi* Stejneger, is discnssed.

Genus **Berardius** Duvernoy, 1851

Berardius arnuxi Duvernoy, 1851

Loc.: Port Lorne in St. Vincent Gulf, South Australia (skull and part skeleton in South Australian Museum; Reg. No. M.5012).

INTRODUCTION

A brief note recording the occnrrence of *Berardius arnuxi* in South Australian waters was published previously (Hale, 1939, pp. 5-6, fig.).

The specimen, a pregnant female, was stranded in December, 1935, on an extensive tidal flat, south of Port Lorne, near the northern end of St. Vincent Gulf. The presence of the whale was not reported to me until early in January, 1936, and, in company with Messrs. J. and A. Rau and an assistant, the carcass was examined on January 6, when some flesh measurements and skeletal details were secnred. The whale then had been carried by the tide to one mile north of Port Lorne, and was resting on the flat nearer to high tide level than when first seen by others. On the same day fleshing was partly carried ont bnt as darkness fell work was interrupted by the invasion of the incoming tide which, as nsnal in this locality, raced across the flat with snrprising speed and force, on this occasion coinciding with a sudden thunderstorm. The partly fleshed carcass was then anchored, secnrely as we thought, to strong stakes, bnt on visiting the site early

next day we found that during a further storm in the night tidal action had gouged out a crater where the whale had been lying and that sections of the body were scattered about the flat. With the aid of a local fisherman all but the major part of the caudal vertebral section, comprising caudals four to nineteen, were recovered. Despite extensive search by the Museum party, and later, following offer of a substantial reward, by residents adjacent to Port Lorne, this portion, regrettably, was never recovered.

External Characters

Mr. J. J. Waters, of Yatala, South Australia, observed, from a small boat, the whale when it was first stranded on December 27, 1935. He supplied, *in litt.*, the following information. "At the time when I saw it first it was at low water; the whale was then about half a mile from low water mark . . . When the tide rose sufficiently for us to go in we went to within twenty yards of it and were going to anchor it. After a time we discovered that it was alive. The only noise that it made was when it expelled air, a loud 'whish'; it was also moving its head from side to side. The colour on close inspection was black. Where it was when I saw it was due west from a big sand bank about two miles south of Port Lorne".

My best thanks are due to the abovementioned for their personal observations and I am indebted to Mr. C. P. Mountford for photographing the bones herein illustrated.

Table 1. Body proportions.

Measurements.	mm.	Per cent of length.
Total length to median projection of tail flukes	8,845	100.0
Tip of snout to anterior ends of throat grooves	381	4.3
Tip of snout to vertical level of anterior corner of eye	915	10.3
Tip of snout to blow hole	1,040	11.7
Tip of mandible to vertical level of anterior corner of eye	864	9.7
Projection of lower jaw beyond tip of snout	51	0.5
Tip of snout to vertical level of anterior end of base of dorsal fin	5,871	66.3
Tip of snout to axilla	1,982	22.4
Width of flukes	2,238	25.3
Height of dorsal fin	153	1.7
Length of base of dorsal fin	534	6.0
Length of pectoral fin, axilla to tip	787	8.9
Greatest width of pectoral fin	432	4.8
Length of eye	38	0.4
Depth of eye	16	0.1

Skeleton

Skull (pl. 5, fig. A-B). This is a little less than one-seventh of the body length. It is of the same size as the type skull of Duvernoy

and in general differs in no very significant detail from the descriptions of other authors. The mesethmoid, however, rises above the level of the premaxillae (cf. Flower, 1874, p. 218, pl. 28, fig. 8) while its rugose ossification extends to approximately 320 mm. in front of the base of the rostrum, as measured between the posterior limits of the antorbital notches, a feature due to the greater age of the Australian female.

Measurements of the skull, mandibles and teeth are given in tables 2 and 3.

Table 2. Skull measurements.

Measurements.	mm.	Per cent of length.
Total (condylobasal) length	1,260	100.0
Height from vertex to inferior border of pterygoids	648	51.4
Breadth across postorbital processes	700	55.5
Length of rostrum	765	60.7
Breadth of rostrum at base	435	34.5
Breadth of rostrum at middle	168	13.3
Length of premaxilla	1,085	86.1
Breadth of premaxillae at middle of length	122	9.6
Greatest breadth of premaxillae in front of nares	218	17.3
Greatest breadth of premaxillae behind nares	200	15.8
Distance from anterior end of premaxillae to level of posterior borders of pterygoids	995	78.9
Length of nares (greatest median)	120	9.5
Breadth of nares (greatest)	98	7.7
Breadth across occipital condyles	220	17.4
Breadth of right condyle	95	7.5
Height of right condyle	154	12.2
Length of mandible (right)	1,155	91.6
Length of symphysis	290	23.0
Height at coronoid	230	18.2
Distance from tip of jaw to centre of 1st tooth	50	3.9
Distance from tip of jaw to centre of 2nd tooth	150	11.9
Height of 1st tooth: right	104	8.2
left	105	8.3
Greatest length of 1st tooth: right	65	5.1
left	70	5.5

Hyoids. The basihyal has the median anterior incision much deeper, and the adjoining prominences more elevated, than in the younger specimen described by Flower (1874, p. 223, pl. 28, fig. 9; body length about the same as that of the Australian female); this bone is two and one-quarter times as wide as its median length, and is more massive than as described by Flower, its breadth being 180 mm. The thyrohyals are not fused to the basihyal and like the stylohyals are also more massive, not much longer, but relatively distinctly wider.

Vertebrae (pl. 6, fig. B-H). Cervical, 7; thoracic, 11; lumbar, 12; caudal, 19.

The vertebrae were counted in the partly fleshed animal but, as already mentioned, most of the caudals were lost during a storm.

There are in hand, however, all cervicals, thoracics and lumbars together with the first to third caudals and three pairs of chevrons, each of the latter with the components fused. The field notes also show that there are ten ribs on the left side and eleven on the right.

The epiphyses are all coalesced with the free ends of the centra, so completely incorporated that they have become an integral part of all of the latter.

In the first three fused cervicals the maximum height of the combined dorsal processes of the first and second is two-sevenths of the greatest depth of the mass, with the upper surface rising, not steeply, to the rear, where there is an irregular median incision between a pair of apical bosses. The atlas is decidedly wider than high. The neural arch of the third cervical is free on both sides for a short distance, above the third large lateral foramen, but is complete, although the dorsal apical portion is fused with, but below the level of, the dorsal part of the arch of the second vertebra. The fourth to seventh cervicals also have complete neural arches. In the fourth and fifth there is no dorsal process, the upper sides of the arch being almost uniform in anterior-posterior width, but sloping slightly upwards dorsally; the fourth is not higher than its greatest width. The sixth has a low, obtusely rounded dorsum and the seventh a short, triangular dorsal process, less than one-seventh of the total height of the vertebra, which thus is wider than high. The centrum of the seventh has a median gutter on the ventral surface, where in the preceding cervicals is a low protuberance.

The dorsal spines of all eleven thoracic vertebrae slope backwards and in general resemble those described and figured by Flower in 1874, although his example had only ten thoracics. The first is wider than high, because of the low dorsal process. The eighth has a pronounced lateral rib-attachment facet on each metapophysis and another articular facet on each side of the posterior end of the centrum. The ninth thoracic has the dorsal process fairly well developed and is nearly twice as high as its greatest width. Each of the prominent lateral processes first appearing on the tenth has a large and rugose articular face on the distal end.

The twelve lumbars differ in no essential feature from those described by Flower. The distal parts of the dorsal processes, however, are inclined towards the left in the first two, towards the right in the third to fifth, again to the left in the sixth and seventh, slightly to the right in the eighth to tenth and to the left in the eleventh. The first lumbar is wider than high and the dorsal process, as in the

thoracics, is rather slender, the greatest width at the distal end being one-fourth of the length, the last measured from the upper limit of the neural arch to the apex. The dorsal process of the remaining lumbars is wider, but the increase in breadth is not successively regular until the ninth; in the eleventh the width of the distal end is not much less than half the length of the process and in the twelfth slightly more than half the length. The sixth lumbar has become much higher than wide.

The first to third caudal vertebrae have the distal end of the dorsal processes, as in the posterior lumbars, expanded and truncate, their apical width being more than half the length. The height of the first caudal is more than one-third as long again as its width.

Sternum (pl. 5, fig. C). The components of each of the five segments are solidly fused. The massive first segment has the whole anterior margin shallowly concave and the lateral articular processes more prominent than as shown in the illustrations of this structure in *arnuxi* (cf. Flower, 1874, pl. 27, fig. 3 and Morelli, 1920, pl. 4, fig. 4). The posterior processes of the last segment are shorter than depicted in the abovementioned illustrations.

Scapula (pl. 6, fig. 1). Resembles very closely the photographs of this bone by Morelli (1920, pl. 4, fig. 3, and pl. 5, fig. 2; adult female of *arnuxi* from La Plata).

Ribs. As already noted, there are ten ribs on the left side and eleven on the right. The eleventh has no trace of a fellow on the left and is much shorter than either of the tenth ribs. The tubercle is rudimentary in the ninth ribs, disappearing on the tenth pair and the single eleventh rib. The differences in the lengths of ribs of a pair, given below, are not significant, depending mainly on the projection of the distal rugosity.

Length of ribs, taken in a straight line from head to free end of bony portions.

Rib No.	Right. mm.	Left. mm.
1	450	450
2	730	710
3	890	895
4	990	970
5	1,015	1,015
6	1,055	1,050
7	1,045	1,040
8	1,040	1,035
9	970	Broken tip
10	825	830
11	435	Absent

DISCUSSION

The two species of *Berardius* recognized in literature occupy, as far as is known at present, widely separated oceanic areas. The genotype, *B. arnuxi* Duvernoy, has been taken from the Antarctic Ocean to South America, New Zealand and southern Australia, while *B. bairdi* Stejneger occurs in the North Pacific, from the Bering Sea to California and Japan.

External Characters

Omura, Fujino and Kimura (1955, p. 99) furnish body proportions of four females of *bairdi* from Japan in percentages of total body length; the South Australian female is compared below with these and other specimens.

The snout was relatively longer, and the lower jaw projected for a lesser distance from the tip of the snout than in the Japanese females. Measurements of a young female, of the same total length as the South Australian specimen, are given by Pike (1953, p. 101); these show the projection of the lower jaw beyond the snout to be still less than in the Australian female.

The throat grooves were approximately 535 mm. in length, and as usual did not meet in front; posteriorly they were separated by a distance of 380 mm. As shown in Table 1 the eye was well in advance of the blowhole.

The dorsal fin, although approximately equal in length to those of the Japanese females, was considerably lower. This fin is high in some other females referred to *bairdi*; for instance see True, 1910, p. 67 and Pike, 1953, p. 101. True, *vide* Hector, indicates that the dorsal fin of the Wellington, New Zealand, male *arnuxi* is relatively still higher.

The pectoral fins were fully as long and wide as those of the Japanese females.

The caudal fin showed no trace of a median notch; on the contrary the rear edges of both flukes were concave, a little sinuate and met medianly to form a slight but distinct projection (fig. 1), the tip of which was only 77 mm. posterior to the last, and tiny, caudal vertebra. The flukes were not symmetrical, the left, measured from tip to the median projection, being 1,069 mm. in width, the right 1,169 mm. The total width of the caudal fin corresponds with the proportion to body length of a large adult female of *bairdi* from Alaska, as given by True (1910, p. 67) and while less than that of the abovementioned Japanese females, is greater than stated in the few available body measurements of *arnuxi*.

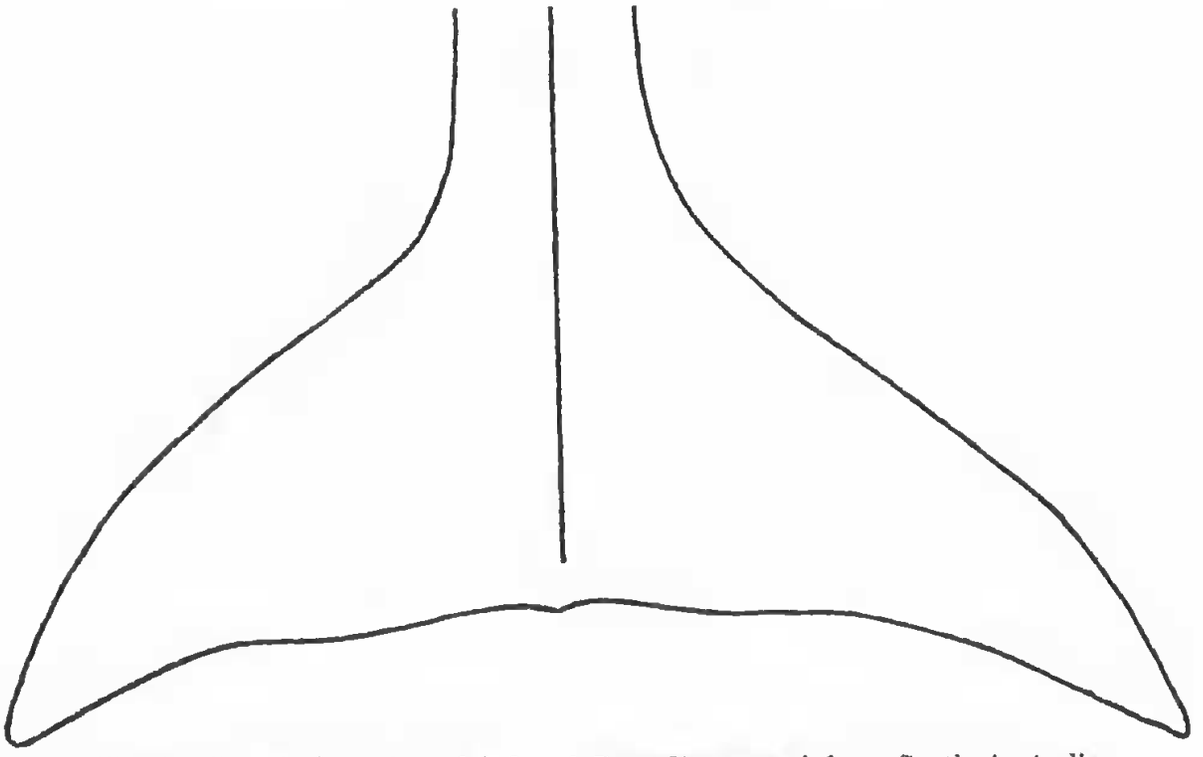

Fig. 1. Dorsal view of caudal fin of *Berardius arnuxi* from South Australia (1/18 nat. size).

It is possible that the posterior margins of the tail flukes of the South Australian *Berardius* had been damaged, and healed, during life, but it is difficult to imagine that in such case the width of the caudal fin could be increased, but if anything the reverse. Mutilation of the fins of living whales is by no means unusual (see for example R. M. Gilmore, Journ. Mamm., 42, 1961, pp. 419-420).

The distortion of the dorsal processes of the lumbar vertebrae suggest that the whale suffered a mishap at some period of its existence.

Skeleton

In Table 3 the skull measurements, per cent of breadth, of the South Australian female are compared with those of two females referred to *bairdi*. One, not fully adult and taken off the coast of Vancouver Island, British Columbia (Pike, 1953, p. 103) is equal in size to the South Australian example. The second, from the opposite side of the North Pacific, is a larger adult female (Omura, Fujino and Kimura, 1955, p. 109). The last column refers to a "physically adult" *Berardius*, thought to be a female, and not specifically identified, from near Ocean City, Washington (Slipp and Wilke, 1953, p. 108).

Table 3.

Measurements.	S. Aust. 29ft. adult.	Vancouver Is. 29ft. immature.	Japan. 36ft. adult.	Washington. 34ft. 5in. adult.
Total (condylobasal) length	180.0	203.8	196.8	181.8
Height from vertex to inferior border of pterygoids	92.5	79.7	79.1	73.6
Breadth across postorbital processes	100.0	100.0	100.0	100.0
Length of rostrum	109.2	132.0	127.6	116.7
Breadth of rostrum at base	65.0	60.2	60.5	56.3
Breadth of rostrum at middle	24.0	29.4	27.8	26.0
Length of premaxilla	155.0	180.9	191.1	162.6
Breadth of premaxilla at middle of length	17.4	20.9	15.7	15.7
Greatest breadth of premaxillae in front of nares	31.1	36.3	31.9	31.1
Greatest width of premaxillae behind nares	28.5	30.8	26.6	27.2
Distance from anterior end of premaxillae to level of posterior border of pterygoids	142.1	131.3	162.0	141.8
Length of nares (greatest median)	17.1	16.7	19.5	17.1
Breadth of nares (greatest)	14.0	19.0	15.9	16.6
Breadth across occipital condyles	31.1	32.8	33.0	27.9
Breadth of right condyle	13.5	15.2	15.1	13.9
Height of right condyle	22.0	26.3	22.6	21.6
Length of mandible (right)	165.0	180.6	180.1	—
Height at coronoid	32.8	32.2	32.4	28.2

The South Australian skull has the rostrum shorter and wider at the base than in the three North Pacific examples but otherwise exhibits no measurements of significance. The proportions of the rostrum, moreover, can hardly be regarded as important, for according to True's cited measurements of *arnuxi* in the New Zealand examples it is longer, and narrower basally, than in the Australian specimen, and falls within the range of *bairdi*. Remington Kellogg (in Slipp and Wilke, 1953, p. 109) writes "So far as can be judged from the five *bairdii* skulls in this Museum [U.S. National Museum], the breadth of the rostrum at the base . . . seems to vary considerably".

In short, the measurements of these and other skulls of *Berardius* support True's statement (1910, p. 69) concerning the skulls of the few specimens discussed by him "there appears to be nothing which can be fixed upon in this small series to distinguish the two species by dimensions alone".

As far as can be ascertained with the bones *in situ* the tympanics and perioties resemble those figured by True (1919, pl. 35. 37, fig. 7) for *bairdi* rather than Flower's illustrations of these bones in *arnuxi* from Canterbury, New Zealand.

The mandibles (pl. 6, fig. A) are relatively deeper than in the adult female from Japan referred to *bairdi*, and 36 feet in length

(Omura, Fujino and Kimura, pl. 9); also than in the female (?) of Slipp and Wilke (1953, p. 108), 34 feet in length, in which the depth at the coronoid is 222-223 mm., this measurement in the South Australian example being almost 5 per cent greater, notwithstanding the smaller size of the last named specimen. In Flower's description (1874, p. 221) of *arnuxi* from New Zealand, about 30 feet in length and yet "far from adult" the depth at the coronoid is given as only 8.3 inches, or about 205 mm.

When the carcass was first seen by me at Port Lorne the posterior of the two pairs of teeth were in place, slightly moveable in their sockets and with the tips projecting slightly above the gum. According to eyewitnesses the large anterior teeth also were loose in their sockets and approximately an inch of the apical portion of each was exposed and obvious, thus tempting a visitor forcibly to remove them. Fortunately, thanks to the prompt action of the district police officer, Constable Mahony, these teeth were recovered during the first day of our operations.

As indicated by the measurements, the anterior-posterior length of the front tooth of the right mandible is less than that of the left; the right tooth had been extracted with very little damage to the alveolus but the distal part of the left mandible is broken on the outer face although its tip is intact (pl. 6, fig. A). The large teeth, when fitted into their respective sockets, are forwardly inclined in the jaw, although less so than in the second pair; both anterior teeth have the root completely closed, thick and rugose.

In the immature *arnuxi* described by Flower (1874, p. 222) the pulp cavity in the first pair of teeth is completely closed below, while the tips, as in the South Australian female, show little or no sign of abrasion. These teeth in larger females (*bairdi*) from Japan, and 33-35 feet in length, show definite apical erosion (Omura, Fujino and Kimura, 1955, pl. 6, fig. 1-2) but those of an immature Japanese female of about the same length as the South Australian female, are much as in the latter.

Table 4 provides measurements, per cent of condylobasal length of skull, of some vertebrae and the scapula of two adult females of *Berardius*. Right column, *bairdi* from Japan, 36 feet in body length; skull 1,421 mm. in length (Omura, Fujino and Kimura, 1955, p. 111). Left column, *arnuxi* from South Australia, 29 feet in body length; skull 1,260 mm. in length. The incorporated epiphyses are included in the length of the centra of the vertebrae in the Australian

specimen, as presumably they must have been in the adult Japanese female.

Table 4.

Measurements.	Per cent length of skull.	
Atlas:		
Breadth	19.4	22.9
Height	16.6	21.3
Fourth cervical:		
Greatest height	15.6	16.3
Greatest width	15.7	14.0
Length of centrum	2.3	2.6
Seventh cervical:		
Greatest height	17.8	16.8
Greatest width	19.3	13.2
Length of centrum	3.7	2.9
First thoracic:		
Greatest height	19.4	23.2
Greatest width	20.3	19.9
Length of centrum	4.6	4.4
Ninth thoracic:		
Greatest height	28.5	32.5
Greatest width	14.4	18.4
Length of centrum	12.0	11.8
First lumbar:		
Greatest height	36.1	38.4
Greatest width	38.0	38.4
Length of centrum	14.2	14.4
Sixth lumbar:		
Greatest height	42.0	46.5
Greatest width	36.1	38.4
Length of centrum	17.8	17.0
First caudal:		
Greatest height	47.2	51.1
Greatest width	34.9	36.2
Length of centrum	20.2	20.9
Length of scapula	40.8	44.8
Height of scapula	31.7	34.2

In the Australian female the skull is proportionally longer than in the larger Japanese female, 14.2 as against 12.9 per cent of body length. If the Australian skull were relatively as short as that of the Japanese female the ratios given for the vertebrae would be about one-tenth greater and thus in some approximately or quite equal to those for the Japanese specimen. Minor differences in the vertebrae probably represent only individual variation. It is known that the ratio of skull length to body length is variable in *Berardius*. True (1910, p. 67), relying on limited data, considered that *arnuxi* has a relatively larger skull than *bairdi*. On the other hand Omura, Fujino and Kimura (1955, p. 119) note that in *arnuxi* the posterior caudals are smaller than in *bairdi* (also True, 1910, p. 72). The abbreviation of

the caudal region may be a constant character in *arnuxi* but here again examination of further southern examples is desirable.

From descriptions and figures it is evident that the sternum of *Berardius* is subject to considerable variation, particularly anteriorly and posteriorly. That of the South Australian specimen is composed of five thick bones, in the first of which the anterior border, as noted above is widely concave (pl. 5, fig. C).

The scapula of the Australian specimen is much more like that of *Hyperoodon planifrons* (see Hale, Rec. S. Aust. Mus., IV, 1931, fig. 18), and of the *Berardius arnuxi* illustrated by Morelli in 1920, than as shown in True's figure (1910, pl. 33, fig. 2) of this bone in *Berardius bairdi.*

CONCLUSION

With information recorded to date one cannot but accept with some reservation the premise that the caudal fin is constantly relatively wider, and the pectoral fin larger, in *bairdi* than in *arnuxi.* This was suggested by True (1910, p. 67) and supported by Pike (1953, pp. 100-102) as well as Omura, Fujino and Kimura (1955, pp. 106 and 119). If these constitute the only differences, the validity of *bairdi* as a true species would be questionable; the features of the South Australian female alone tends to raise a doubt (see Table 1 herein), although it would seem that *Berardius,* possibly because of a longer caudal region, attains a greater adult length in the North Pacific than it does in southern seas. Bearing in mind the great distance between the known distribution areas of *arnuxi* and *bairdi* it is reasonable to regard them as separate forms; future records of *Berardius* may throw further light on the status of the two living representatives of the genus.

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EXPLANATION OF PLATES 5 AND 6

PLATE 5.

Berardius arnuxi from South Australia. A and B, lateral and upper views of skull (1/10 nat. size). C, sternum (1/12 nat. size).

PLATE 6.

Berardius arnuxi from South Australia. A, mandibles. B to H, vertebrae; B, cervicals; C to F, first, eight, uinth and tenth thoracics; G, first lumbar; H, first caudal. I, scapula (all 1/9 nat. size).